Coke's and Lichtenstein's Hartebeests representing the transitional stages to the purely Cape form *Bubalis caama*.

There is a very curious breed of cattle which is the common form in Urundi, Karagwe, and Mpororo, and also occurs sporadically in Buddu. The most singular feature is the enormous horns, sometimes three feet long and as far apart at the tips. The udder is very small and the hump inconspicuous. They are brown all over, not like the other breeds. They have a peculiar way of walking; the fore and hind feet seem to reach the same spot, so that their paths constitute a series of transverse ridges separated by furrows. It seems that they are closely related to the Galla or Sanga Ox of Abyssinia, which were first discovered by Bruce. The Wahima race, which are in a purer condition in this part of Africa than anywhere else, probably brought these animals with them from Abyssinia, and they have probably remained ever since in this country, *i. e.* about 5000–7000 feet in the Urundi hills and also in Mpororo.

The following papers were read :—

1. On the Structure of the Heart of the Alligator. By Frank E. Beddard, F.R.S., Prosector to the Society, and P. Chalmers Mitchell, M.A., F.Z.S.

[Received May 6, 1894.]

We have recently had the opportunity of examining the heart of a large Alligator (*Alligator lucius*), lately living in the Society's Reptile-house. As none of the existing figures of the heart of this Crocodilian, particularly of the valves, appears to us adequate, it seems to be worth while to enter into the matter again. The best and most numerous illustrations of the heart are contained in a work by Prof. Sabatier [1]. None of them, however, shows clearly the relative proportions of muscle and fibrous tissue in the auriculo-ventricular valves, which is a matter of such importance in comparing the hearts of the higher vertebrates. Gegenbaur's well-known paper upon the heart of the Crocodile and the Monotreme [2] has no illustrations at all, while Prof. Lankester [3] has, in our opinion, not given an absolutely accurate figure of the right auriculo-ventricular valve, though the illustration is sufficient to bring out the points with which he was concerned in the paper, which did not profess to be a detailed description of the Crocodile's heart. The heart of the Alligator, as has already been noted, lies exceedingly far back in the abdominal cavity enclosed

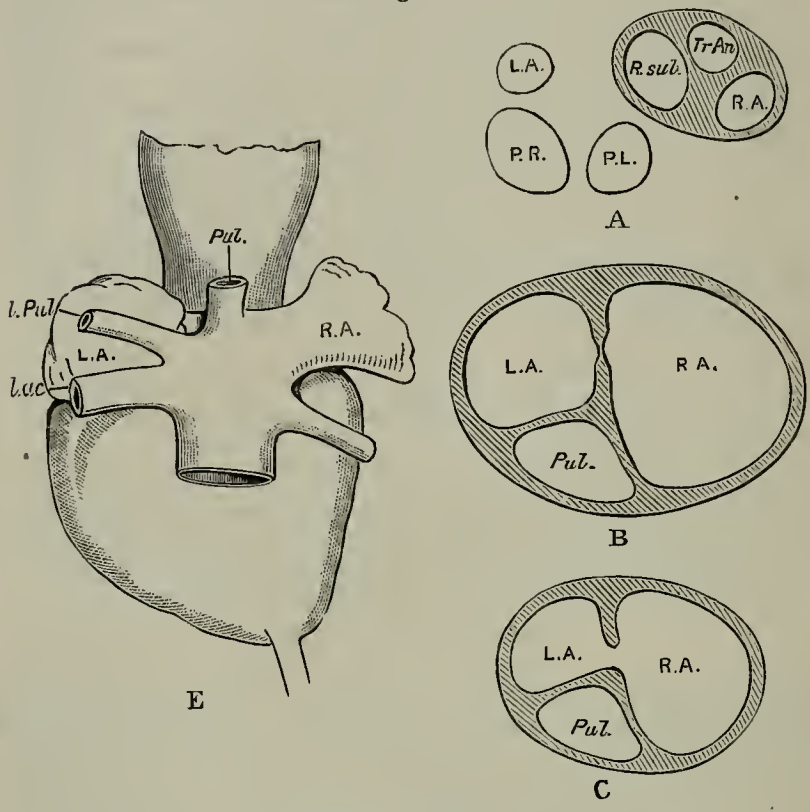
[1] "Le Cœur et la Circulation des Vertébrés," Inaug. Diss., Montpellier, 1873.

[2] "Zur vergleichenden Anatomie des Herzens," Jen. Zeitschr. 1866.

[3] "On the Right Cardiac Valve of *Echidna*, etc.," P. Z. S. 1883, p. 8, pl. iv. figs. 1, 2.

in a stout pericardium of an elastic nature. The pericardium ensheathes the origins of the large vessels, and the point of the ventricles is bound to the posterior end of the pericardium by a stout gubernaculum, as in many Lizards but not in Birds.

Fig. 1.



Heart of Alligator.

A, B, C. *Sections through the bulbus at different horizons.*

C. In the region of the aortic valves the communication between the aortæ is shown. B. In the largest part of the bulb; A very narrow window separates the aortæ in one region. A. At the summit of the bulb. *Pul.* Common pulmonary trunk on ventral side: P.R., P.L. Right and left pulmonaries. L.A. Left aorta arising from right ventricle; R.A. Right aorta. *R.sub.* Right subclavian: *Tr.An.* Truncus anonymus.

E. *Dorsal aspect of heart.*

L.A. Left auricle. R.A. Right auricle. The letters *Pul.* are placed upon the base of the arterial bulb: the ventricles, with the gubernaculum attached to the apex, form the lower part of the figure. *Pul.* Right pulmonary vein; *l.Pul.* Left pulmonary vein, which is closely attached externally to the left anterior vena cava, *l.a.c.* The right anterior vena cava opens into the sinus opposite *l.a.c.* The large median vessel is the post-caval.

The accompanying drawing (E) illustrates the dorsal aspect of the heart with the sinus venosus overlying it; the sinus venosus is a very small but distinct thin-walled cavity, in position and

arrangement markedly recalling that of the Frog. Anteriorly and to the left side the large left anterior cava opens into it; the much smaller right anterior cava opens opposite to the latter on the right side. The postcaval vein enters the sinus in the middle line posteriorly and is of enormously large size. A large coronary vein leaves the line of junction between the ventricles and enters the postcaval after a short free course.

The two auricles are free from the surface of the ventricles, thus differing from birds; they are attached to the dorsal side of the heart, and their free ends are partially wrapped round but do not meet on the ventral side. The right auricle is markedly longer than the left and its free extremity is forked.

The line of junction between the ventricles is plainly marked exteriorly; and it passes down immediately to the right of the gubernaculum, which is thus attached to the left ventricle only. The great vessels which arise from the ventricles are closely attached to each other and form an enormous bulging expansion anterior to the heart, and showing externally no trace of a division into the separate vessels. The accompanying drawings are illustrative of sections through this bulbus arteriosus at different levels.

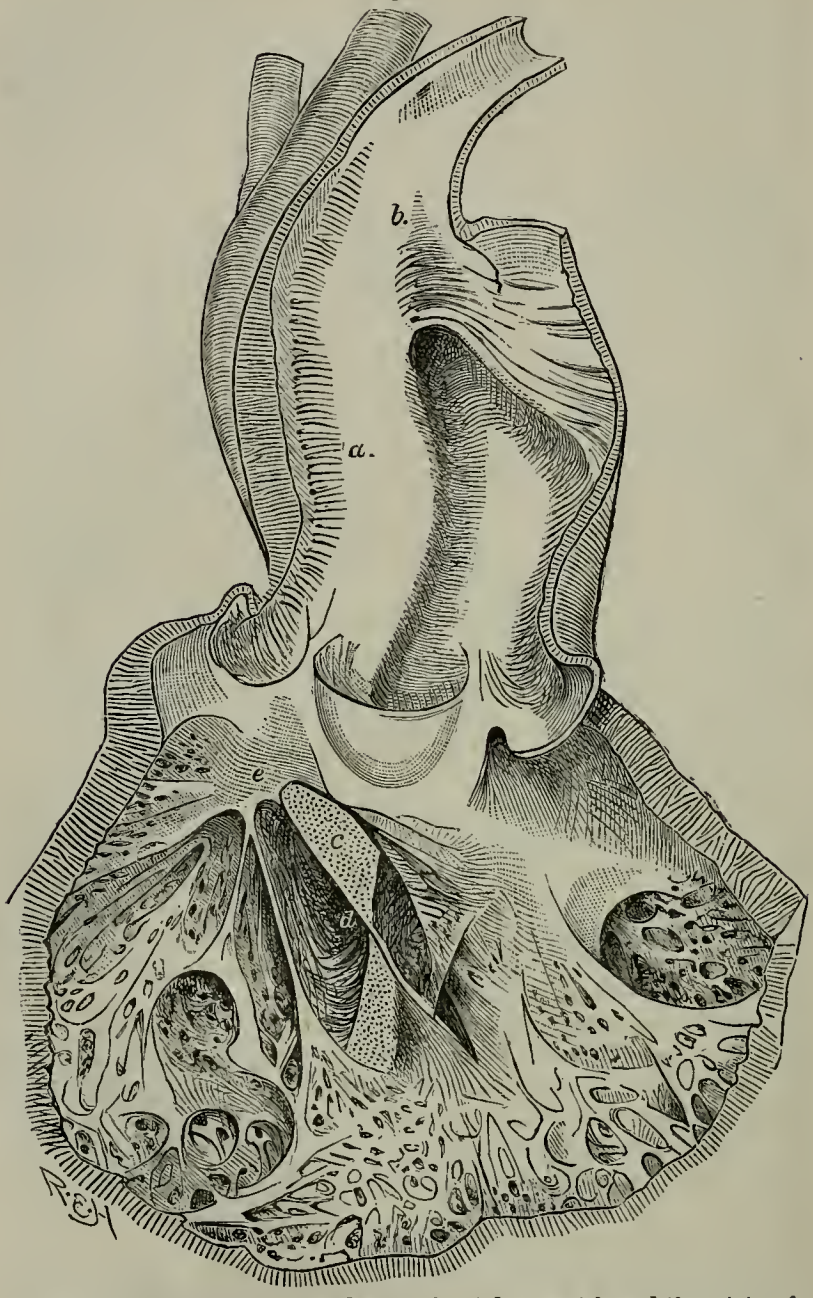
The pulmonary veins enter the dorsal side of the heart towards the left hand; the right pulmonary vein being exactly in the middle line, and the left entering at right angles to it and attached by membrane to the left precaval.

Cavities of the Heart.—The small cavity of the sinus venosus leads directly into the right auricle; the valve between them (atrio-auricular) is bicuspid, being composed of two large thin muscular flaps, each semicircular and like an eyelid in shape; the dorsal valve is slightly overlapped by the ventral at the sides, and the two do not join. The cavity of the right auricle is twice as large as that of the left; the septum between the two is complete and lies in the middle dorsal line of the heart. The interior of both auricles is richly sculptured.

The most striking point, of course, about the interior of the ventricles is the enormous thickness of the spongy walls and the very small amount of free cavity. When the apex was cut off, a well-marked line, concave towards the left ventricle, and situated in the middle of the spongy tissue, showed the boundary of the inter-ventricular septum. The spongy cavities ran closely up to this line, but in no case was it actually penetrated by them. There is in short an absolute separation between the two ventricles.

The *right auriculo-ventricular valve* consists of two separate valvular flaps equal in size; the septal, or inner flap is chiefly muscular, but a triangular piece near the upper free extremity is chiefly membranous, as is shown in the drawing (woodcut fig. 2, *c*). The strand of muscle running along the valve arises by a column with several roots from the septal wall of the heart posteriorly. The right, or outer, valve is entirely muscular (fig. 2, *d*); its upper surface is sculptured, chiefly in vertical lines, and bound to the

Fig. 2.



Heart of Alligator, opened to display the right ventricle and the origin of left aorta.

a & *b*. Two rows of rudimentary valves, the row opposite *b* being shorter and having a deep pit under the lowest of three chief rudimentary valves.

c. Septal flap of right auriculo-ventricular valve; the membranous area is dotted, and a strong muscular band ties down the lower end of the flap to the septal wall.

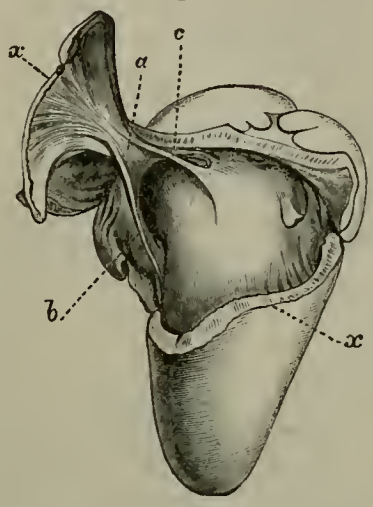
d. Fleshy half of right auriculo-ventricular valve .

e. Muscular band tying down junction of two flaps, and corresponding to bridge in bird's heart.

parietes by delicate muscular threads, which may be compared with the papillary muscles of the valves of the mammalian heart.

In spite of the luminous investigations of Prof. Lankester upon this matter, and of the previously expressed views of one of us [1], we cannot regard the morphological relationship of the different parts of the valve of this animal and that of the bird as thoroughly cleared up.

Fig. 3.



Heart of the Common Fowl, opened to display the cavity of the right ventricle.

x, *x*. Cut surfaces.

b. Right part of the valve identified by us with right part of valve in Alligator (fig. 2, *d*). *c*. Septal part of valve identified by us with Alligator's septal flap (fig. 2, *c*). *a*. Muscular bridge identified by us with structure shown in fig. 2, *e*.

The view taken by Prof. Lankester, and generally accepted, is that the entire fleshy valve of the right (*b*) ventricle of the Bird's heart corresponds to one half only of the complete valve of the Crocodile [2] and of the Mammal; in the Bird it is held that the septal half of the valve is quite absent and not even represented by rudiment. Now, if we consider the Bird's heart in a position exactly corresponding to that of the Alligator as shown in our drawing (fig. 3), this comparison seems to be inexact. The larger half of the valve lies on the right side, and is of course entirely fleshy; in the Ostrich, which we have recently had an opportunity of examining and which was typically avian in every respect, this half of the valve was slightly sculptured on its right face near to the origin from the walls of the heart. A comparison in this matter with the corresponding face of the same valve in the Alligator will

[1] F. E. Beddard, "On the Heart of Apteryx," P. Z. S. 1885, p. 188, and "Notes on the Anatomy of the Condor," P. Z. S. 1890, p. 142.

[2] "Bei Vögeln am rechten Ostium die mediale endocardiale Taschenklappe der Krokodile vollständig geschwunden," Röse, Morph. Jahrb. 1890, p. 80.

be obvious (see fig. 2). As will be seen by an inspection of the accompanying drawing (fig. 3), which we are enabled to reproduce here by the courtesy of Prof. Lankester, this half of the valve is bound down anteriorly to the outer wall of the ventricle by a strong muscular bridge. This muscular bridge is also connected with the anterior edge of another valve which is much shorter than the one just described, but which runs approximately in the same direction as the last, *i. e.* nearly parallel to the longitudinal axis of the heart. This has generally been accepted as part of the longer valve and as not corresponding to the septal flap. We are, however, unable to agree with this interpretation of the structure. In its relations it corresponds exactly to the septal flap of the valve of the Alligator; the upper end of the two valves in the Alligator are in the same way bound down by a strong band of muscle; it is true that this muscle does not form a definite bridge, but it stands out in relief, and as the spongy wall of the ventricle is so much thicker, we cannot regard the obliteration of the space beneath as of any morphological significance: in fact we identify what has been called the inner part of the valve in the Bird's heart as the septal flap of the valve of the Alligator's heart. It is identical in relative position, in its mode of attachment; and in some birds we have seen a slight development of tendon in its substance. Furthermore, the direction of the muscular fibres is not continuous round what has been regarded as the continuous edge of the valve. As to its disproportion in size, we do not see that the amount of development as compared with the nature of the development is a point of much significance.

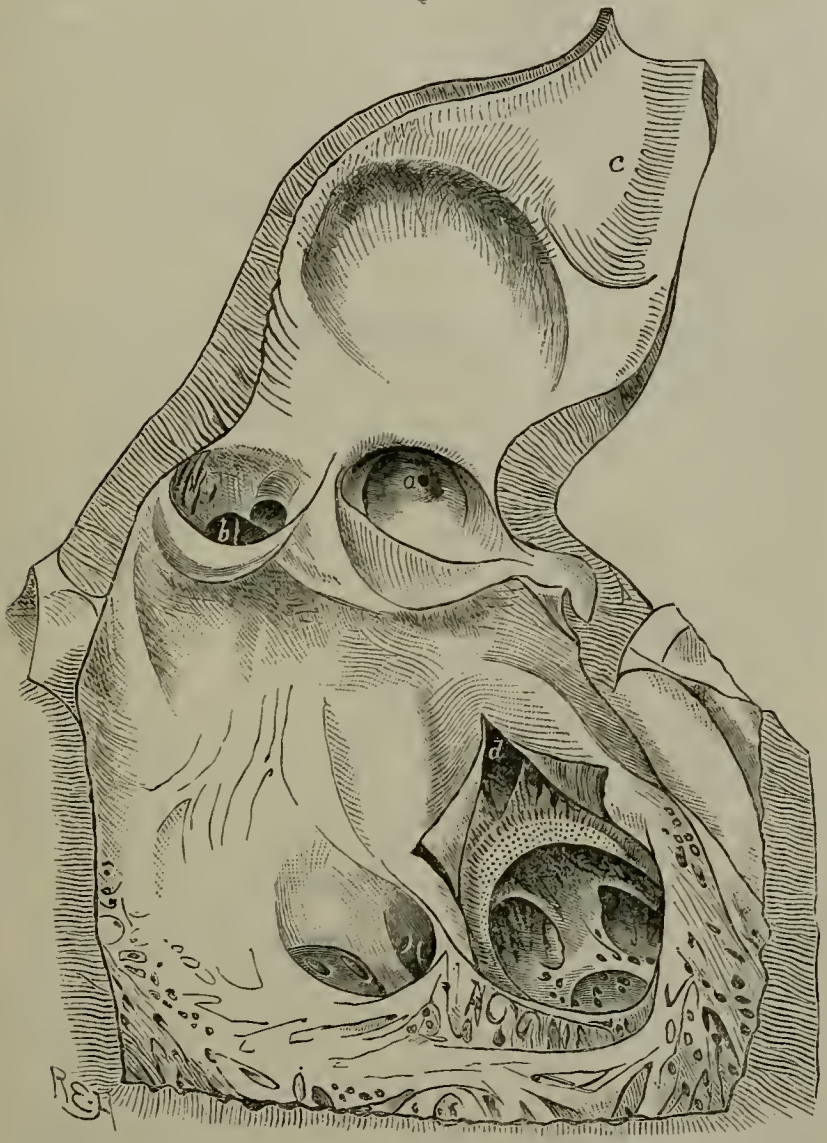
The left auriculo-ventricular valve, illustrated in the drawing (fig. 4), consists of two separate vertical flaps, of which the septal is considerably larger and overlaps the left flap; the septal valve is thinner, and is composed of both muscles and tendon. The left half of the valve has the free crescentic edge strongly ligamentous, the remaining part being muscular.

The left aorta arises of course from the right ventricle; its exit is guarded by three watch-pocket valves, on the free edge of which are cartilaginous hardenings; the exit is narrow, and the aorta then dilates into a wide chamber in the bulbus. In this are two rows of small sculpturings like rudimentary valves extending to the top of the wide part of the aorta, each row being vertically above the middle of one of the valves (fig. 2, *a*, *b*). The pulmonary artery arises from the same ventricle; its exit is similarly guarded by three valves and it similarly dilates into a wide expansion in the bulbus; the pulmonary artery at the end of the dilatation divides into two branches, which, however, leave the bulbus on its ventral aspect and not, as figured in Wiedersheim, on the dorsal aspect.

The right aorta arises from the left ventricle; its narrow exit is guarded by two wide valves, behind the left of which arises the coronary artery. Behind the right lies the very large communication with the left aorta. The aorta then expands into a very wide sac in the bulbus; in a line with the communication between

the two aortæ, and nearly an inch and a half anterior to it, there is a deep pit in the right aorta, shown in the drawing (fig. 1, B). This is separated by a transparent window from the space behind the lowest of the three principal rudimentary valve-like structures in the left aorta; however, there is no actual communication.

Fig. 4.



Heart of Alligator, opened to show the left ventricle and origin of the right aorta.

a. Aperture of coronary artery. *b*. Foramen Panizzi. *c*. Right aortic arch. *d*. Outer or left flap of left auriculo-ventricular valve cut through to show, underlying it, the septal flap of the same valve, which is larger in size, and the membranous margin of which is indicated by the dotted area in the drawing.